Atmosphere Basics

For

Explorer Post 632

BalloonSat

6 October 2004

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Why "Understand" Atmosphere?

- **Atmosphere governs the balloon behavior.**
  - Rise rates.
  - Winds determine Drift rates.
  - Fall rates (Air resistance).
- **Atmosphere determines types of measurements that can be made.**
  - Atmosphere properties are of interest.
  - How close to space conditions?
  - What are we looking through?

Units

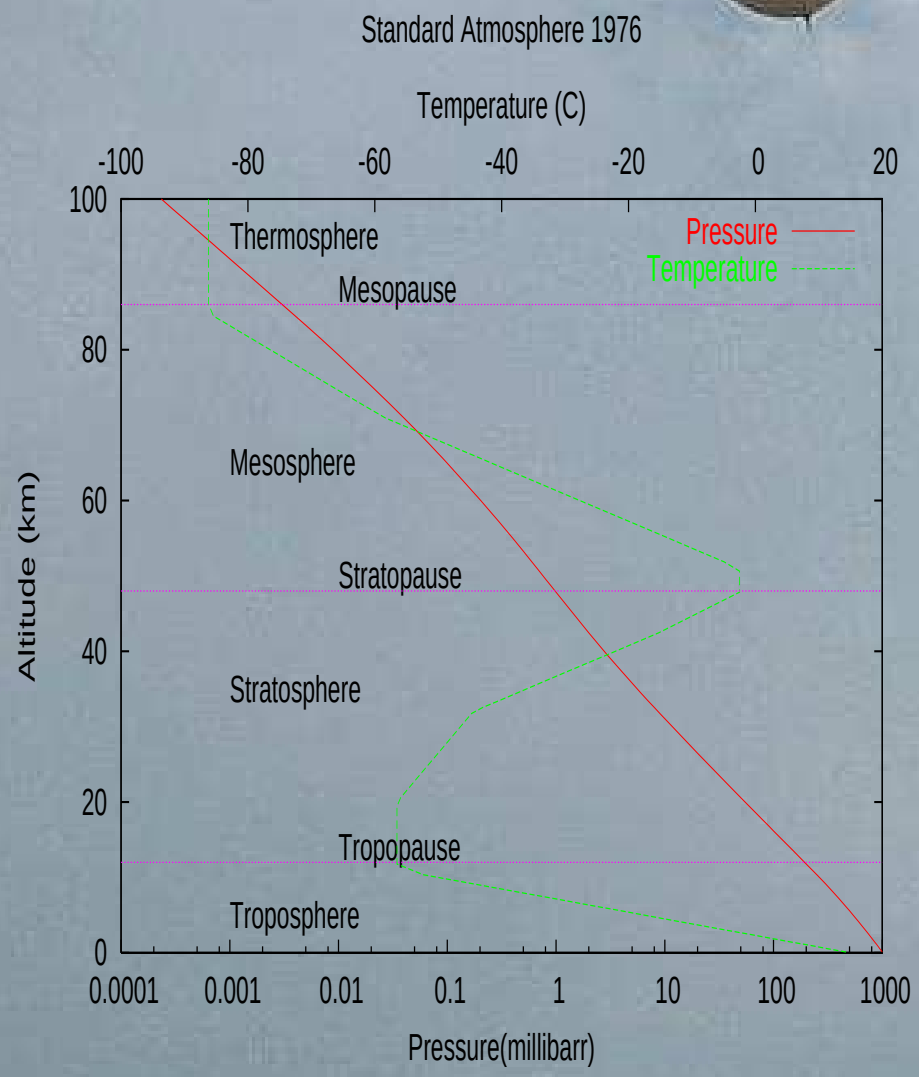
Altitude

Feet	Meters	Kilometers	Miles
Conversion	Ft*0.3048	M /1000	Ft/5280
0	0	0	0
500	152.4	0.15	0.09
10000	3048	3.05	1.89
35000	10668	10.67	6.63
50000	15240	15.24	9.47
80000	24384	24.38	15.15
100000	30480	30.48	18.94
120000	36576	36.58	22.73

Pressure

Atm	Millibar	PSI	Torr	In Hg
	Dyne/cm^2	lb/in^2	Mm Hg	
Conversion	Atm*1013.25	Atm*14.70	Atm*760	Atm*29.92
1.0000	1013.3	14.700	760.0	29.920
0.5000	506.6	7.350	380.0	14.960
0.1000	101.3	1.470	76.0	2.992
0.0050	5.1	0.074	3.8	0.150
0.0010	1.0	0.015	0.8	0.030
0.0005	0.5	0.007	0.4	0.015

Atmosphere Layers



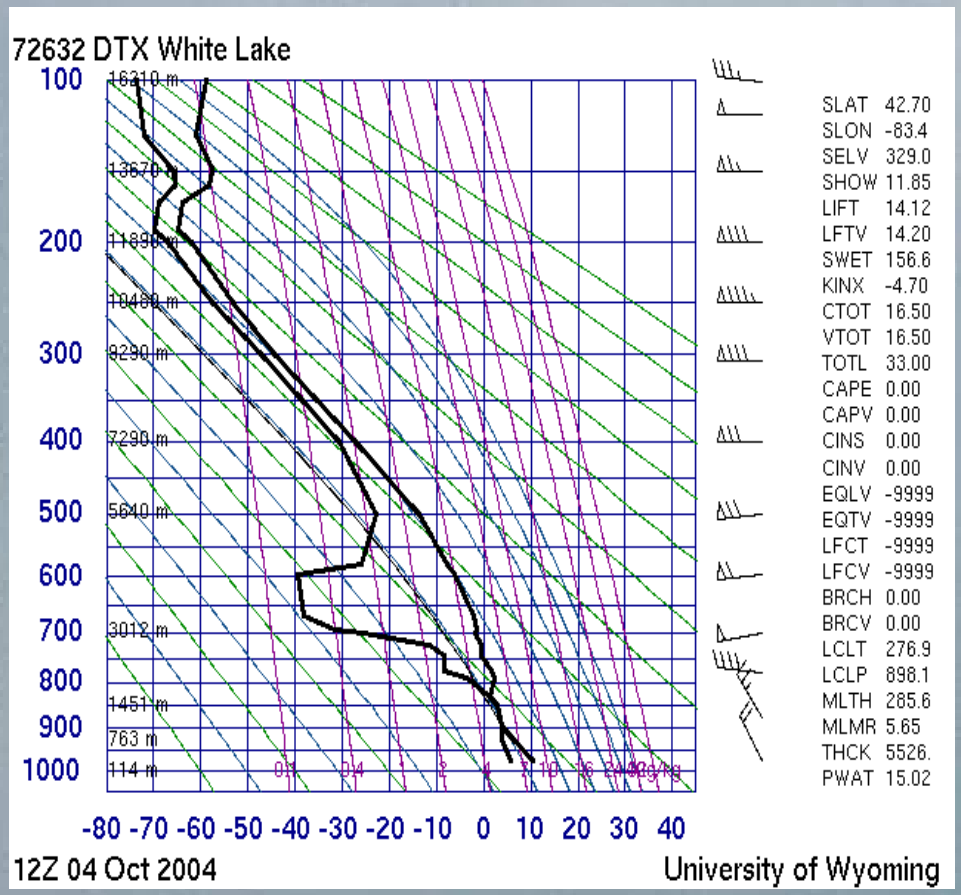
Atmosphere has *four* layers

- **Troposphere** (0 to 6-10 mi)
  - Lowest
  - Weather
- **Stratosphere** (t0 30 mi)
  - Dry
  - Ozone Layer
- **Mesosphere** (to 50 mi)
  - Cold (-100 C)
- **Thermosphere** (to 600 mi)
  - Hot (1200 C)
  - Atomic Oxygen
  - Ionosphere

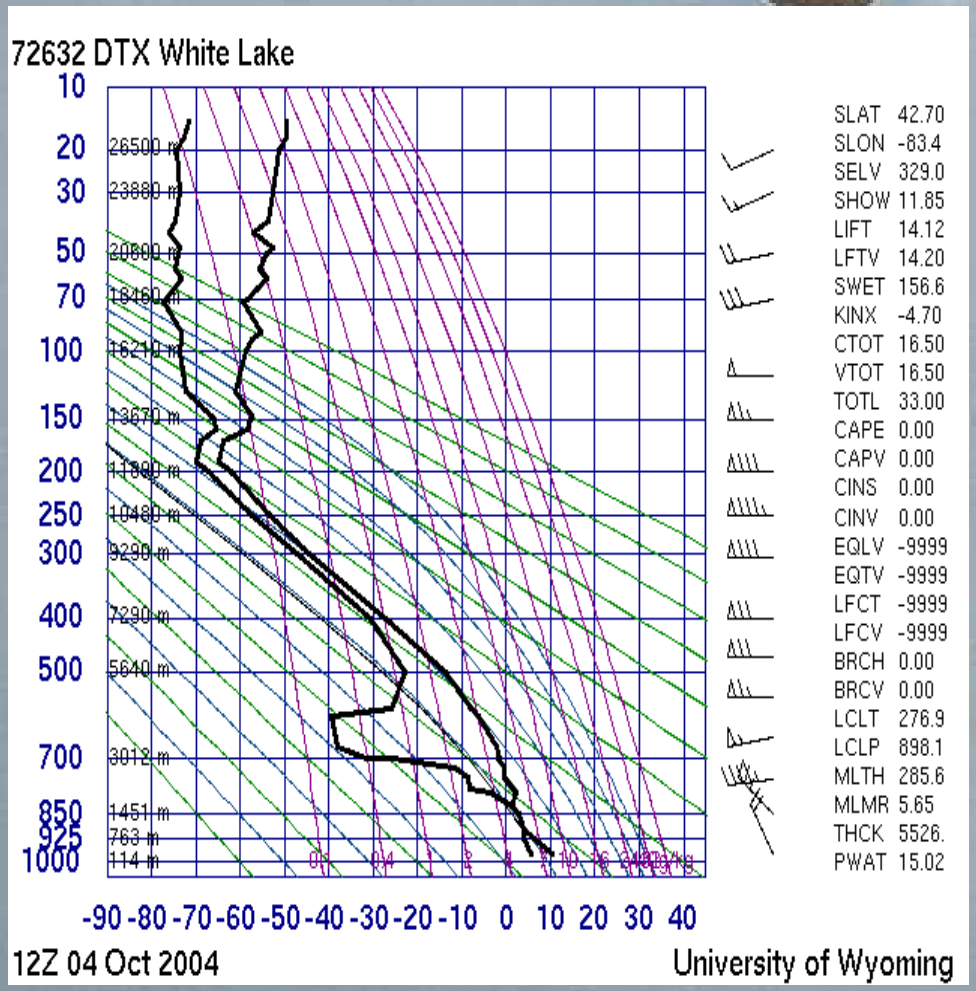
Troposphere

“tropos”, “turn”, Circulation

- **Weather**
- **75% of atmosphere**
- **Water Vapor (Clouds)**
- **Dust, Pollution**
- **Generally temperature decreases with height (6.5 C/km) except at winter poles.**
- **Increasing wind with height**
- **Tropopause (28kft) Lower at poles than Equator (54kft)**



Stratosphere



"Stratos","layer"

- **Stratified, non-convective**
- **Cold (-40 C)**
- **25% of atmosphere**
- **Ozone layer**
  - UV adsorbed
- **Dry – no clouds**
  - *Dew Point* 20C lower than *Temperature*.
- **Winds**
  - *Decrease* with height in lower part
  - *Increase* with height in upper part.

Upper Atmosphere

Mesosphere

- **50-85 km**
- **Cools with altitude (-100 C)**
- **Cold**
- **Meteors burn up here (Hot?)**
- **Cold**
  - Guess:
    - Too little gas to adsorb solar energy
    - But can radiate to space
- **Noctilucent clouds**
  - Ice clouds, (near polar regions)
  - Seen after sunset
    - Illuminated by sun

Thermosphere

- **80 km-1000 km**
  - Goal of X-Prize (100km)
- **Temperature rises with altitude**
  - from -100 C (+170K)
  - to 1000 C (1300K) near 200 km.
- **Source of most atmospheric visible radiation.**
  - Nightglow, dayglow, aurora
- **Adsorbs ionizing radiation**
- **Contains ionosphere,**
  - Ionized particles (plasma) reflect and adsorb portions of radio spectrum.

Rules of thumb

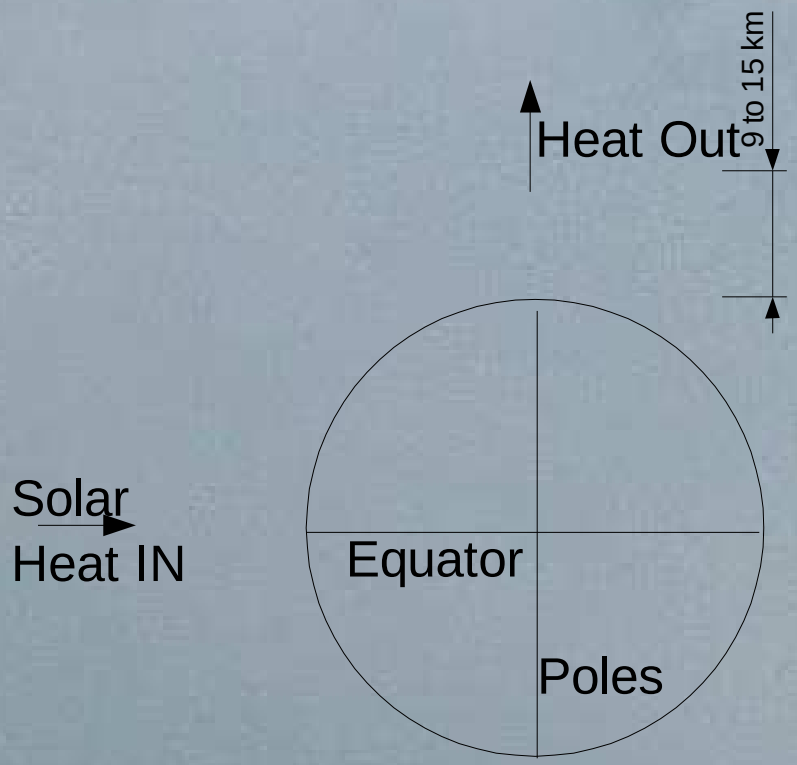
Pressure

- **Pressure is caused by Weight of atmosphere.**
- **Pressure drops 50% in 15kft**
- **Pressure drops ~90% (to 1/10th) in 50kft**
- **Pressure at 30kft is 300mb.**
  - What is pressure at 45 kft?
  - What about 60kft?
- **Pressure at 0 is ~1013 mb.**
  - What is pressure at 50kft?
- **Pressure at 50 kft is really 120mb.**
  - What is pressure at 100kft?

Temperature

- **Tropopause is typically 30 to 40 kft at our latitude.**
- **Troposphere temperature falls ~10 C/10kft.**
- **Tropopause temperature is -50 to -60 C**
- **Temperature is nearly constant in lower stratosphere, then rises.**

Troposphere Circulation



Three Cell Circulation Model
(Troposphere)

Atmospheric circulation is driven by solar heating

- **Heat comes in at the Equator and is released at the poles (and at night)**

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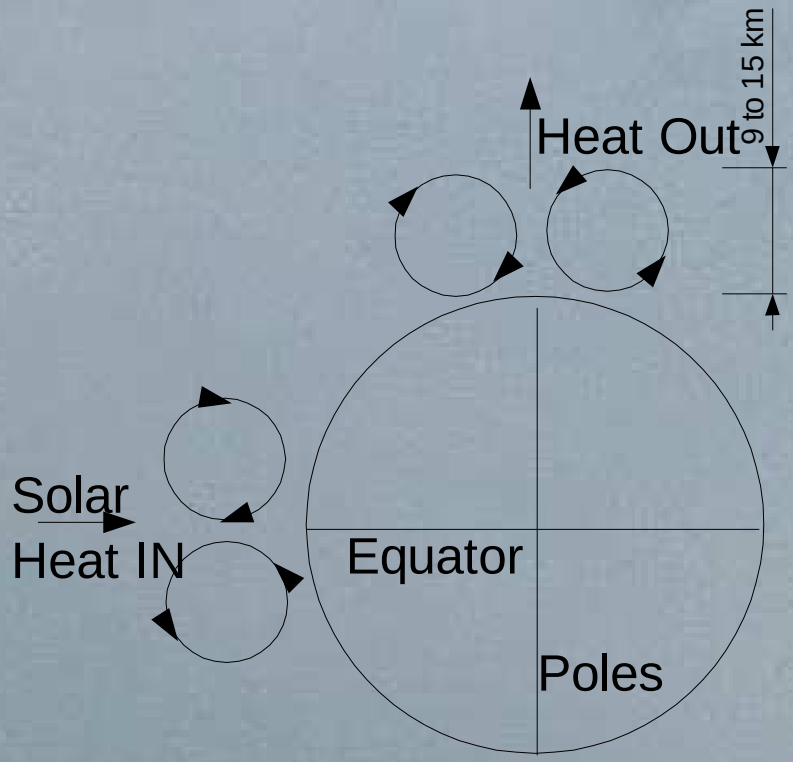

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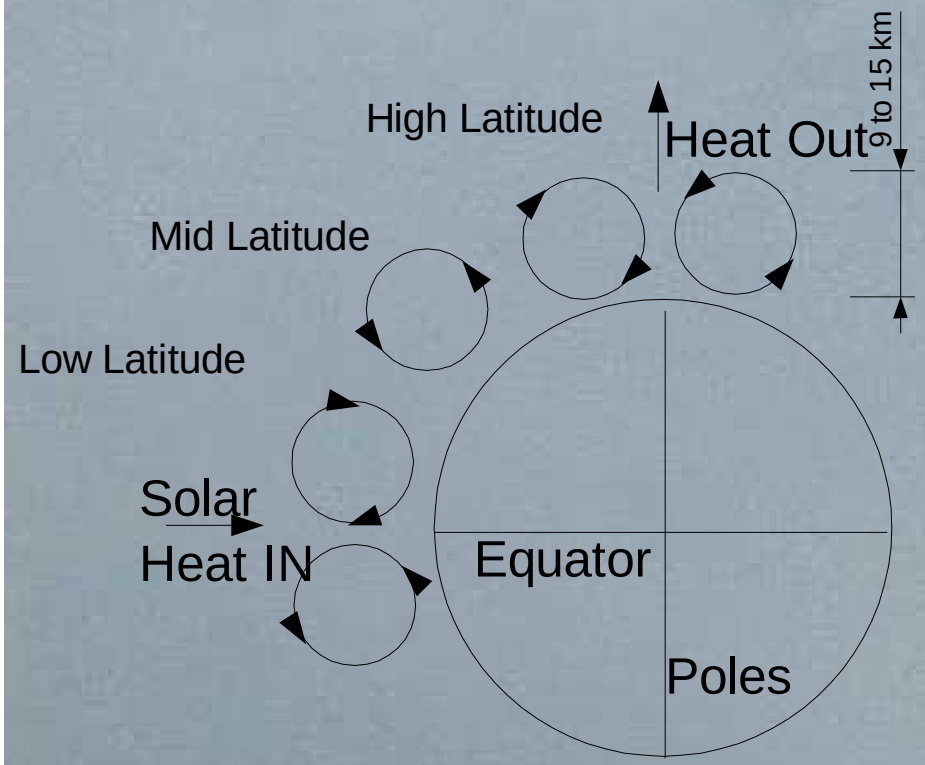

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- **Three circulation bands**
  - Low Latitude (0 to 30 deg)
    -
  - Mid Latitude (30 to 60 deg)
    -
  - High Latitude/Polar(60 to 90)
    -

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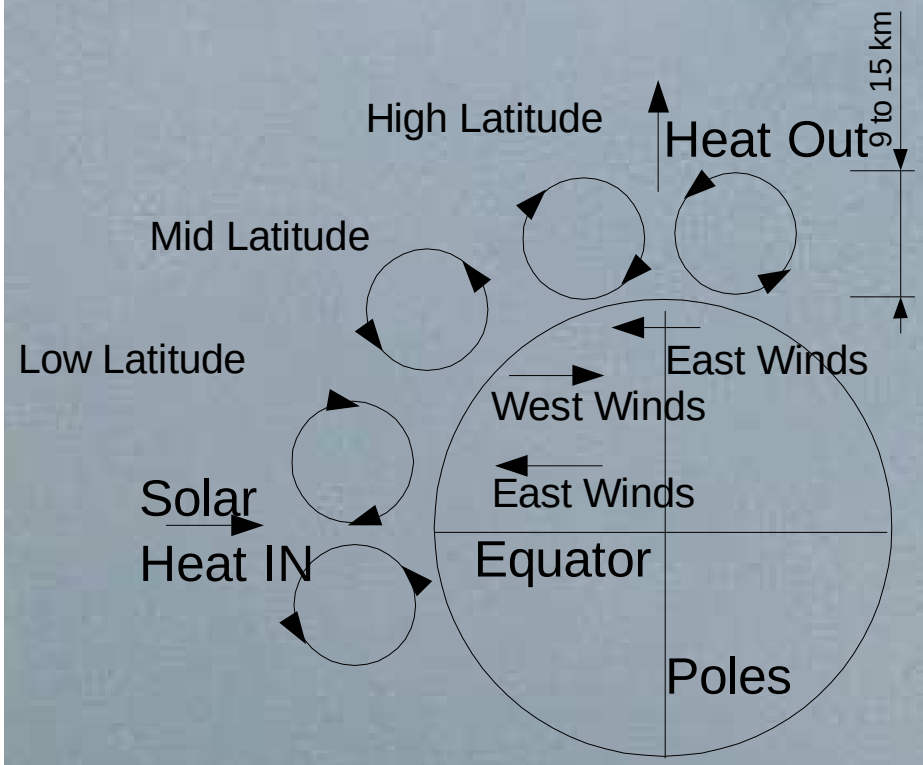

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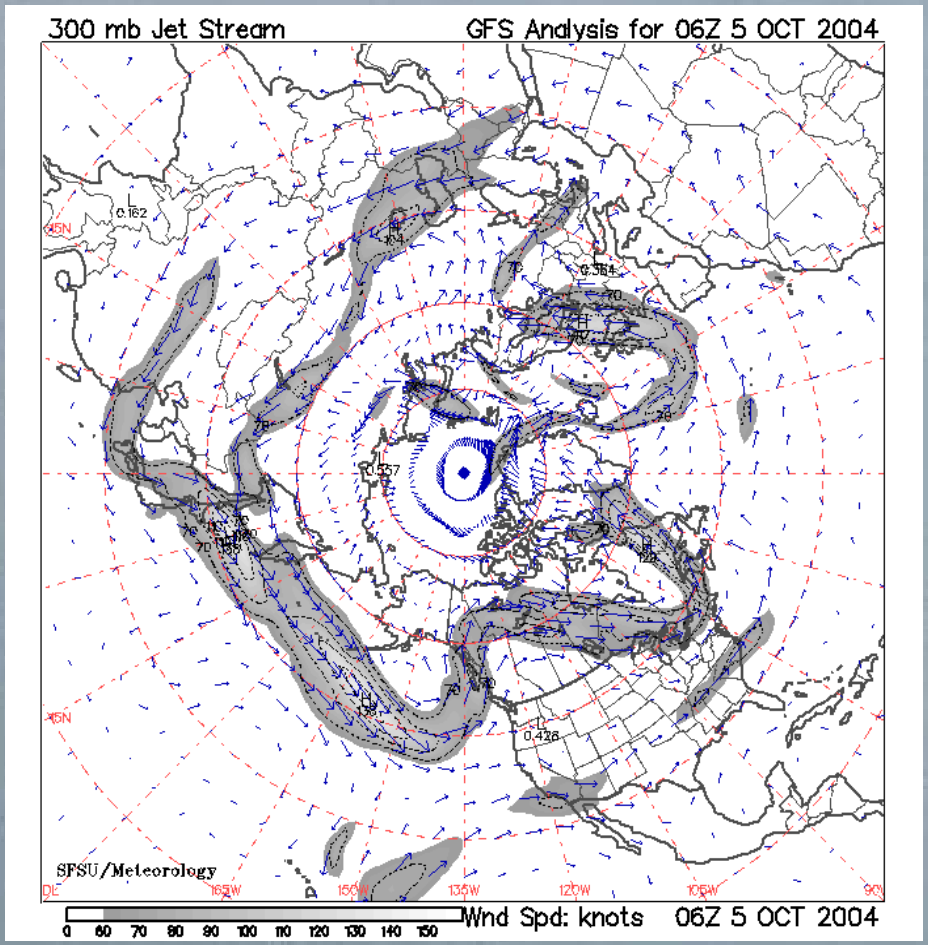
  - Low Latitude (0 to 30 deg)
    - East Trade Winds
  - Mid Latitude (30 to 60 deg)
    - West Trade Winds
  - High Latitude/Polar(60 to 90)
    - Prevailing East winds

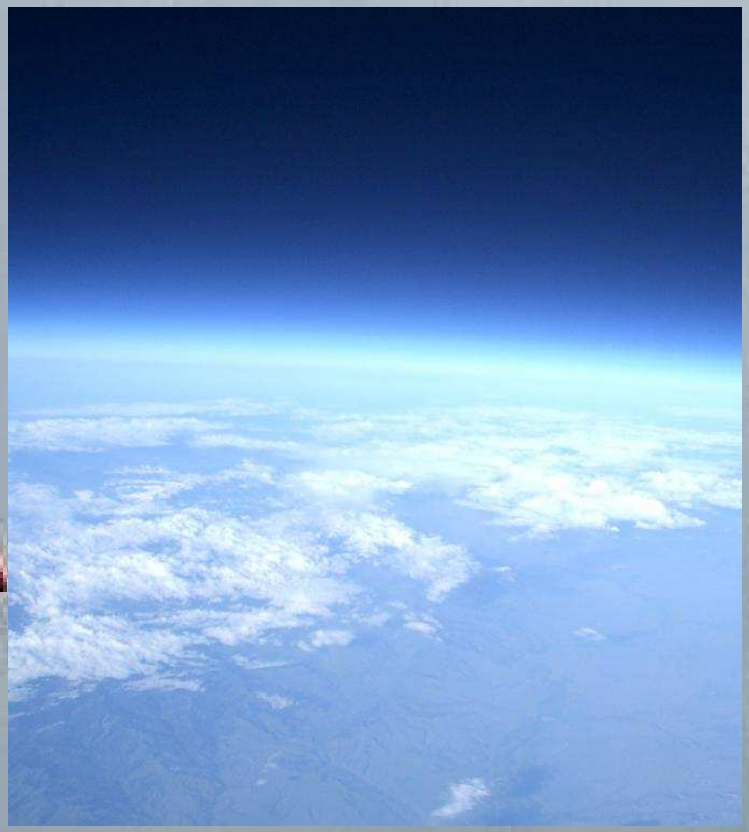
Jet Stream



- **Winds of 100 to 150 mph**
- **Located in mid-latitude cell "near" polar cell.**
  - (Where warm air meets cold air)
  - pushed by large weather systems (High and Low Pressure)
- **Near top of Troposphere**
  - Measured near 300 mb (30kft)
- **Dominates Balloon path.**
  - Balloon will travel fastest here.

Summary

- **Our balloon should go through the troposphere, into the stratosphere (100kft)**
- **Path of the balloon will be dominated tropospheric winds**
  - Westerly (Middle Latitudes)
  - Near Jet Stream at 30,000 ft
- **Pressure is halved about every 15 kft.**
  - Balloon volume doubles every 15 kft
  - Probably won't reach 120 kft
- **Equipment must function at**
  - Near vacuum (Cooling difficult)
  - Cold External Temperatures (-50 C)



Web Sites

Weather Balloon soundings

<http://weather.uwyo.edu/upperair/sounding.html>

Jet Stream

<http://squall.sfsu.edu/crws/jetstream.html>

<http://www.weatherimages.org/data/imag192.html>

Weather Balloon Information

<http://www.amsat.org/amsat/balloons/balloon.htm>

<http://www.eoss.org/>

<http://spacegrant.montana.edu/borealis>

Balloon Launch announcements

<http://users.crosspaths.net/wallio/ARHAB%20Launch%20Announcements.html>

A Weather Balloon Experiment

<http://www.suntracker.eng.wayne.edu>